Claims

1. A method of measuring an ion beam performed in an ion implanting apparatus for irradiating an ion beam to a target by parallelly scanning the ion beam in an x direction, said ion implanting apparatus including a forestage multipoints Faraday and a poststage multipoints Faraday constituted by respectively installing pluralities of detectors for measuring a beam current of the ion beam parallelly in the x direction respectively on an upstream side and a downstream side of the target, said ion implanting apparatus further comprising: a forestage beam restricting shutter provided at a vicinity on an upstream side of the forestage mutlipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction; a forestage shutter driving apparatus for driving the forestage beam restricting shutter in a y direction orthogonal to the x direction; a poststage beam restricting shutter provided at a vicinity on an upstream side of the poststage multipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction; and a poststage shutter driving apparatus for driving the poststage beam restricting shutter in the y direction, said method comprising:

a poststage beam current density distribution measuring step of calculating a beam current density distribution in the y direction of the ion beam at a position of the forestage beam restricting shutter by measuring a change in the beam current of the ion beam

incident on the forestage multipoints Faraday by passing an outer side of the side of the forestage beam restricting shutter while driving the forestage beam restricting shutter in the y direction by the forestage shutter driving apparatus;

a forestage center position calculating step of calculating a center position y_{cf} in the y direction of the ion beam at the position of the forestage beam restricting shutter from the beam current density distribution calculated at the forestage beam current density distribution measuring step;

a postage beam current density distribution measuring step of calculating a beam current density distribution in the y direction of the ion beam at a position of the poststage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the poststage multipoints Faraday by passing an outer side of the side of the poststage beam restricting shutter while driving the poststage beam restricting shutter in the y direction by the poststage shutter driving apparatus;

a poststage center position calculating step of calculating a center position y_{cb} in the y direction of the ion beam at the position of the poststage beam restricting shutter from the beam current density distribution calculated at the poststage beam current density distribution measuring step; and

an angle deviation calculating step of calculating an angle deviation θ_y in the y direction of the ion beam based on the following equation or an equation mathematically equivalent thereto by using

the center position y_{cf} calculated at the forestage center position calculating step, the center position y_{cb} calculated at the poststage center position calculating step and a distance L between the forestage beam restricting shutter and the poststage beam restricting shutter.

$$\theta_y = \tan^{-1} \{(y_{cb} - y_{cf})/L\}$$

2. A method of measuring an ion beam performed in an ion implanting apparatus for irradiating an ion beam to a target by parallelly scanning the ion beam in an x direction, said ion implanting apparatus including a forestage multipoints Faraday and a poststage multipoints Faraday constituted by respectively installing pluralities of detectors for measuring a beam current of the ion beam parallelly in the x direction respectively on an upstream side and a downstream side of the target, said ion implanting apparatus further comprising: a forestage beam restricting shutter provided at a vicinity on an upstream side of the forestage mutlipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction; a forestage shutter driving apparatus for driving the forestage beam restricting shutter in a y direction orthogonal to the x direction; a poststage beam restricting shutter provided at a vicinity on an upstream side of the poststage multipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction; and a poststage shutter driving apparatus for driving the poststage beam restricting

shutter in the y direction, said method comprising:

a poststage beam current density distribution measuring step of calculating a beam current density distribution in the y direction of the ion beam at a position of the forestage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the forestage multipoints Faraday by passing an outer side of the side of the forestage beam restricting shutter while driving the forestage beam restricting shutter in the y direction by the forestage shutter driving apparatus;

a forestage beam size calculating step of calculating a beam size d_{yf} in the y direction of the ion beam at the position of the forestage beam restricting shutter from the beam current density distribution calculated at the forestage beam current density distribution measuring step;

a poststage beam current density distribution measuring step of calculating a beam current density distribution in the y direction of the ion beam at the position of the poststage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the poststage multipoints Faraday by passing an outer side of the side of the poststage beam restricting shutter while driving the poststage beam restricting shutter in the y direction by the poststage shutter driving apparatus;

a poststage beam size calculating step of calculating a beam size d_{yb} in the y direction of the ion beam at the position of the poststage beam restricting shutter from the beam current density

distribution calculated at the poststage beam current density distribution measuring step; and

a diverging angle calculating step of calculating a diverging angle α_{max} in the y direction of the ion beam based on the following equation or an equation mathematically equivalent thereto by using the beam size d_{yf} calculated at the forestage beam size calculating step, the beam size d_{yb} calculated at the poststage beam size calculating step and a distance L between the forestage beam restricting shutter and the poststage beam restricting shutter.

$$\alpha_{max} = \tan^{-1} \{(d_{yb} - d_{yf})/2L\}$$

3. A method of measuring an ion beam performed in an ion implanting apparatus for irradiating an ion beam to a target by parallelly scanning the ion beam in an x direction, said ion implanting apparatus including a forestage multipoints Faraday and a poststage multipoints Faraday constituted by respectively installing pluralities of detectors for measuring a beam current of the ion beam parallelly in the x direction respectively on an upstream side and a downstream side of the target, said ion implanting apparatus further comprising: a forestage beam restricting shutter provided at a vicinity on an upstream side of the forestage mutlipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction; a forestage shutter driving apparatus for driving the forestage beam restricting shutter in a y direction orthogonal to the x direction; a poststage beam

restricting shutter provided at a vicinity on an upstream side of the poststage multipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction; and a poststage shutter driving apparatus for driving the poststage beam restricting shutter in the y direction, said method comprising:

a poststage beam current density distribution measuring step of calculating a beam current density distribution in the y direction of the ion beam at a position of the forestage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the forestage multipoints Faraday by passing an outer side of the side of the forestage beam restricting shutter while driving the forestage beam restricting shutter in the y direction by the forestage shutter driving apparatus;

a forestage beam size calculating step of calculating a beam size d_{yf} in the y direction of the ion beam at the position of the forestage beam restricting shutter from the beam current density distribution calculated at the forestage beam current density distribution measuring step;

a poststage beam current density distribution measuring step of calculating a beam current density distribution in the y direction of the ion beam at the position of the poststage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the poststage multipoints Faraday by passing an outer side of the side of the poststage beam restricting shutter while driving the poststage beam restricting shutter in the y direction

by the poststage shutter driving apparatus;

a poststage beam size calculating step of calculating a beam size d_{yb} in the y direction of the ion beam at the position of the poststage beam restricting shutter from the beam current density distribution calculated at the poststage beam current density distribution measuring step; and

a beam size calculating step of calculating a beam size d_{yt} in the y direction of the ion beam on the target based on the following equation or an equation mathematically equivalent thereto by using the beam size d_{yf} calculated at the forestage beam size calculating step, the beam size d_{yb} calculated at the poststage beam calculating step, a distance L between the forestage beam restricting shutter and the poststage beam restricting shutter, a distance L_1 between the forestage beam restricting shutter and the target and a distance L_2 between the target and the poststage beam restricting shutter.

$$d_{yt} = (L_2/L)\ d_{yf} + (L_1/L)\ d_{yb},\ \text{(where } L = L_1 + L_2\text{)}$$

4. The method of measuring an ion beam according to Claim 1, characterized in further comprising:

a forestage beam size calculating step of calculating a beam size d_{yf} in the y direction of the ion beam at the position of the forestage beam restricting shutter from the beam current density distribution calculated at the forestage beam current density distribution measuring step;

a poststage beam size calculating step of calculating a beam

size d_{yb} in the y direction of the ion beam at the position of the poststage beam restricting shutter from the beam current density distribution calculated at the poststage beam current density distribution measuring step; and

a diverging angle calculating step of calculating a diverging angle α_{max} in the y direction of the ion beam based on the following equation or an equation mathematically equivalent thereto by using the beam size d_{yf} calculated at the forestage beam size calculating step, the beam size d_{yb} calculated at the poststage beam size calculating step and a distance L between the forestage beam restricting shutter and the poststage beam restricting shutter.

$$\alpha_{max} = \tan^{-1} \{(d_{yb} - d_{yf})/2L\}$$

5. The method of measuring an ion beam according to Claim 4, characterized in further comprising:

a beam size calculating step of calculating a beam size d_{yt} in the y direction of the ion beam on the target based on the following equation or an equation equivalent thereto by using the beam size d_{yf} calculated at the forestage beam size calculating step, the beam size d_{yb} calculated at the poststage beam size calculating step, the distance L between the forestage beam restricting shutter and the poststage beam restricting shutter, a distance L_1 between the forestage beam restricting shutter and the target and a distance L_2 between the target and the poststage beam restricting shutter.

$$d_{yt} = (L_2/L)\ d_{yf} + (L_1/L)\ d_{yb}, \quad (\text{where } L = L_1 + L_2)$$

6. An ion implanting apparatus for irradiating an ion beam to a target by parallelly scanning the ion beam in an x direction, said ion implanting apparatus including a forestage multipoints Faraday and a poststage multipoints Faraday constituted by respectively installing pluralities of detectors for measuring a beam current of the ion beam parallelly in the x direction respectively on an upstream side and a downstream side of the target, said ion implanting apparatus comprising:

a forestage beam restricting shutter provided at a vicinity on an upstream side of the forestage mutlipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction;

a forestage shutter driving apparatus for driving the forestage beam restricting shutter in a y direction orthogonal to the x direction;

a poststage beam restricting shutter provided at a vicinity on an upstream side of the poststage multipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction; and

a poststage shutter driving apparatus for driving the poststage beam restricting shutter in the y direction, further comprising:

a control apparatus for executing (a) a forestage beam current density measuring processing of calculating a beam current density

distribution in the y direction of the ion beam at a position of the forestage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the forestage multipoints Faraday by passing an outer side of the side of the forestage beam restricting shutter while driving the forestage beam restricting shutter in the y direction by the forestage shutter driving apparatus, (b) a center position calculating step of calculating a center position y_{cf} in the y direction of the ion beam at the position of the forestage beam restricting shutter from the beam current density distribution calculated at the forestage beam current distribution measuring processing, (c) a postage beam current density distribution measuring processing of calculating a beam current density distribution in the y direction of the ion beam at a position of the poststage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the poststage multipoint Faraday by passing an outer side of the side of the poststage beam restricting shutter while driving the poststage beam restricting shutter in the y direction by the poststage shutter driving apparatus, (d) a poststage center position calculating step of calculating a center position y_{cb} in the y direction of the ion beam at the position of the poststage beam restricting shutter from the beam current density distribution calculated at the poststage beam current density distribution measuring step, and (e) an angle deviation calculating processing of calculating an angle deviation θ_y in the y direction of the ion beam based on the following equation or an

equation mathematically equivalent thereto by using the center position y_{cf} calculated at the forestage center position calculating processing, the center position y_{cb} calculated at the poststage center position calculating processing and a distance L between the forestage beam restricting shutter and the poststage beam restricting shutter.

$$\theta_y = \tan^{-1} \{(y_{cb} - y_{cf})/L\}$$

7. An ion implanting apparatus for irradiating an ion beam to a target by parallelly scanning the ion beam in an x direction, said ion implanting apparatus including a forestage multipoints Faraday and a poststage multipoints Faraday constituted by respectively installing pluralities of detectors for measuring a beam current of the ion beam parallelly in the x direction respectively on an upstream side and a downstream side of the target, said ion implanting apparatus comprising:

a forestage beam restricting shutter provided at a vicinity on an upstream side of the forestage mutlipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction;

a forestage shutter driving apparatus for driving the forestage beam restricting shutter in a y direction orthogonal to the x direction;

a poststage beam restricting shutter provided at a vicinity on an upstream side of the poststage multipoints Faraday, capable

of blocking the ion beam and having a side in parallel with the x direction; and

a poststage shutter driving apparatus for driving the poststage beam restricting shutter in the y direction, further comprising:

a control apparatus for executing (a) a forestage beam current density measuring processing of calculating a beam current density distribution in the y direction of the ion beam at a position of the forestage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the forestage multipoints Faraday by passing an outer side of the side of the forestage beam restricting shutter while driving the forestage beam restricting shutter in the y direction by the forestage shutter driving apparatus, (b) a forestage beam size calculating processing of calculating a beam size d_{yf} in the y direction of the ion beam at a position of the forestage beam restricting shutter from the beam current density distribution calculated at the forestage beam current density distribution measuring step, (c) a poststage beam current density distribution measuring processing of calculating a beam current density distribution in the y direction of the ion beam at a position of the poststage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the poststage multipoints Faraday by passing an outer side of the side of the poststage beam restricting shutter by driving the poststage beam restricting shutter in the y direction by the poststage shutter driving apparatus,

(d) a poststage beam current beam size calculating processing of calculating a beam size d_{yb} in the y direction of the ion beam at the position of the poststage beam restricting shutter from the beam current density distribution calculated at the poststage beam current density distribution measuring processing, and (e) a diverging angle calculating processing of calculating a diverging angle α_{max} in the y direction of the ion beam based on the following equation or an equation mathematically equivalent thereto by using the beam size d_{yf} calculated at the forestage beam size calculating processing, the beam size d_{yb} calculated at the poststage beam size calculating processing and a distance L between the forestage beam restricting shutter and the postage beam restricting shutter.

$$\alpha_{max} = \tan^{-1} \{(d_{yb} - d_{yf})/2L\}$$

8. An ion implanting apparatus for irradiating an ion beam to a target by parallelly scanning the ion beam in an x direction, said ion implanting apparatus including a forestage multipoints Faraday and a poststage multipoints Faraday constituted by respectively installing pluralities of detectors for measuring a beam current of the ion beam parallelly in the x direction respectively on an upstream side and a downstream side of the target, said ion implanting apparatus comprising:

a forestage beam restricting shutter provided at a vicinity on an upstream side of the forestage mutlipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x

direction;

a forestage shutter driving apparatus for driving the forestage beam restricting shutter in a y direction orthogonal to the x direction;

a poststage beam restricting shutter provided at a vicinity on an upstream side of the poststage multipoints Faraday, capable of blocking the ion beam and having a side in parallel with the x direction; and

a poststage shutter driving apparatus for driving the poststage beam restricting shutter in the y direction, further comprising:

a control apparatus for executing (a) a forestage beam current density measuring processing of calculating a beam current density distribution in the y direction of the ion beam at a position of the forestage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the forestage multipoints Faraday by passing an outer side of the side of the forestage beam restricting shutter while driving the forestage beam restricting shutter in the y direction by the forestage shutter driving apparatus, (b) a forestage beam size calculating processing of calculating a beam size d_{yf} in the y direction of the ion beam at a position of the forestage beam restricting shutter from the beam current density distribution calculated at the forestage beam current density distribution measuring step, (c) a poststage beam current density distribution measuring processing of calculating a beam current

density distribution in the y direction of the ion beam at a position of the poststage beam restricting shutter by measuring a change in the beam current of the ion beam incident on the poststage multipoints Faraday by passing an outer side of the side of the poststage beam restricting shutter by driving the poststage beam restricting shutter in the y direction by the poststage shutter driving apparatus, (d) a poststage beam current beam size calculating processing of calculating a beam size d_{yb} in the y direction of the ion beam at the position of the poststage beam restricting shutter from the beam current density distribution calculated at the poststage beam current density distribution measuring processing, and (e) a beam size calculating step of calculating a beam size d_{yt} in the y direction of the ion beam on the target based on the following equation or an equation mathematically equivalent thereto by using the beam size d_{yf} calculated at the forestage beam size calculating processing, the beam size d_{yb} calculated at the poststage beam size calculating processing, a distance between the forestage beam restricting shutter and the poststage beam restricting shutter, a distance L_1 between the forestage beam restricting shutter and the target and a distance L_2 between the target and the poststage beam restricting shutter.

$$d_{yt} = (L_2/L)\ d_{yf} + (L_1/L)\ d_{yb}, \quad (\text{where } L = L_1 + L_2)$$

9. The ion implanting apparatus according to Claim 6, characterized in that the control apparatus further executes (a)

a forestage beam size calculating processing of calculating a beam size d_{yf} in the y direction of the ion beam at the position of the forestage beam restricting shutter from the beam current density distribution calculated at the forestage beam current density distribution measuring processing, (b) a poststage beam size calculating processing of calculating a beam size d_{yb} in the y direction of the ion beam at the position of the poststage beam restricting shutter from the beam current density distribution calculated at the poststage beam current density distribution measuring processing, and (c) a diverging angle calculating processing of calculating a diverging angle α_{max} in the y direction of the ion beam based on the following equation or an equation mathematically equivalent thereto by using the beam size d_{yf} calculated at the forestage beam size calculating processing, the beam size d_{yb} calculated at the poststage beam size calculating processing and a distance L between the forestage beam restricting shutter and the poststage beam restricting shutter.

$$\alpha_{max} = \tan^{-1} \{(d_{yb} - d_{yf})/2L\}$$

10. The ion implanting apparatus according to Claim 9, characterized in that the control apparatus further executes a beam size calculating processing of calculating a beam size d_{yt} in the y direction of the ion beam on the target based on the following equation or an equation mathematically equivalent thereto by using the beam size d_{yf} calculated at the forestage beam size calculating

processing, the beam size d_{yb} calculated at the poststage beam size calculating processing, the distance L between the forestage beam restricting shutter and the poststage beam restricting shutter, a distance L_1 between the forestage beam restricting shutter and the target and a distance L_2 between the target and the poststage beam restricting shutter.

$$d_{yt} = (L_2/L)\ d_{yf} + (L_1/L)\ d_{yb}, \quad (\text{where } L = L_1 + L_2)$$